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THE SUCTION ABOVE KNEE LEG

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In spite of the great advances made in the past 25 years by limb manufacturers in the construction and fitting of artificial limbs, there is still a great need for new developments and improvements. Simplicity of design, lightness of weight and durability of material are the principles which every limb maker should follow as a rule. The more complicated the apparatus, the less satisfaction for the wearer, and the greater the cost.

The possibility to do away with harnesses, suspenders, belts and hip joints, and to connect the prosthesis directly to the stump in order to simplify, has been in my sub-conscious mind for many years. Particularly the idea of fastening an artificial leg to an above knee stump by means of a created vacuum, and using the suction as connecting link, has fascinated me for a long time. Knowing the principles of a suction pump, and knowing furthermore, that soft bodies can be hardened by compression, I was determined to at least give it a trial, and see if it could be used in creating a new type of limb. When I explained my ideas to Colleagues and Doctor friends, they called it fantastic and impossible, and warned me about the consequences. They expected disturbances in the circulation, since no fresh air would reach the stump, and the constant suction might be harmful. Despite the warning, I nursed my idea, and looked for an amputee who would be willing to try it, no matter what the outcome.

Finally, I found a man although he had bad circulation and heart condition. It was not the case I expected to work with, but since I did not find any better ones, I had to take it. Men with better

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stumps, and in better health did not want to take the risk. A friend of mine, Dr. O. Engelke, who was a medical consultant for the Veterans Administration in Munich, Germany, took great interest in my experiment and kept the patient under close medical observation for two years.

First I took a plaster impression of the patient's stump, made a new wood socket according to the cast and fitted the stump to it. Then I closed the end of the socket, and attached a valve from a flute after drilling a hole through the outside wall of the socket. After that, I cut off the old wood socket from the artificial leg and fastened the new socket temporarily. I called the patient in and went to work. The bare stump was inserted in the socket by keeping the valve open and pushing the air out. The stump worked up and down like a piston, pressing the air out and creating a suction after closing the valve. It was hard work and slow going, but little by little we made progress. Fortunately this man had plenty of time and patience, and every day he spent a few hours in the shop. When he was able to lift the leg from the floor after the suction took effect, I was sure we would lick the problem. What made it so hard and difficult in his case was the fact that his stump was very soft and flabby, and therefore, did not create as much suction as expected. In order to keep the artificial limb from sliding off when the suction failed, I fastened a waist belt with a connection strap to the leg, and thus he could walk up and down for a few minutes. As time went on and the suction took more and more hold of his stump, he could walk around for a longer period of time in the shop without losing it. However, every time the socket got loose, he opened the valve and pressed the stump down, thus pushing the air out, and closed the valve again. During the time he did not wear the leg, he exercised

the stump. As the muscles became harder and more compact, the leg did not slide off any more and finally he began to walk outside of the shop, and on the street. Once in a while he had to stop and re-adjust the suction, which he could do by just pressing the lever of the valve through the trouser, but in about four weeks after we started, he could take the leg home and used it regularly. On his way to his office he passed my shop every day for a check up and adjustment.

According to the increase of his thigh muscles, I had to cut out the inside of the suction socket, and as time went on there was practically no wall left. I had to make the second socket, and attached a new suction valve to it, which in the meantime I had devised. The first temporary valve from a flute had proved unsatisfactory so the new type was intended to remedy its faults.

During a period of about two months, the stump perspired very much, and sometimes the bottom of the socket was full of sweat. By putting a sponge pad in the bottom, we eliminated this difficulty and later on the perspiration decreased and the stump stayed dry.

At the start of our experiment the stump was soft, flabby, pale, and moist, due to the heart condition and bad circulation. Later it developed into a healthy, hard,muscular, and pinkish looking stump. It was impossible to pull the leg off his stump and yet it took only a slight lift of the valve lever to release the suction and detach the socket from the stump. Later experience showed this to be true of all properly fitted legs with suction sockets. Seven other legs were later constructed successfully.

We never encountered any harmful disturbance apart from reddening, and discoloring of the end of the stump caused by too tight a fit. The discoloring and sometimes painful swelling always disappeared as soon as the pressure in the tight part of the socket was relieved,

and this only happened during the period of stump adjustment. Later on we never observed any harmful disturbance, and the stumps looked as clean and healthy as the opposite legs. Hot or cold weather had no influence on the condition of the stump, and every wearer of the suction leg assured us of having more comfort in a suction leg than in a previously worn conventional leg.

There is no "flesh shuck", pivoting, or snaky motion in walking stride, and much less friction than in ordinary legs. Soft and flabby stumps however, do have more friction at the start, but later when the muscles harden, there is hardly any pumping. The suction socket has the tendency to suck or draw the flesh downward in the socket in contrast to ordinary legs which push the flesh up and cause protruding flesh rolls which can be very annoying and uncomfortable. After a suction socket is properly fitted and adjusted, the wearer has a feeling that the artificial leg is part of his body, "grown on", and at any time under his control. There is no lost motion as in ordinary legs and the feeling of security is 100%. The artificial leg feels very light since the renewed and powerful muscles of the thigh pick it up and control it so easily. The remaining air in the vacuum socket works as a cushion, thus helping to keep the stump floating and prevent the pumping motion. The weight bearing part of the leg is the ischial tuberosity. It is advisable to keep the walls of the wood socket slightly thicker than usual in order to be able to adjust the socket according to the expansion of the stump.

The most important part is the close fitting of the socket which must be done without a stump sock, because <u>no sock</u> will be worn with the suction leg. Newer amputation cases are better than old ones, as the shrinking process has not been completed and it does not take so long to build up the muscles again. The harder and more compact the stump, the better it is. However, soft and flabby

stumps will be built up and hardened by using the suction leg. My first experimental case required three new sockets during a period of two years, and each one had to be made larger according to the increase of the thigh muscles.

By the time I left Germany in 1937, I had made seven more suction legs for stumps varying between five and twelve inches, and every one was a success.

A conical stump is harder to fit than a cylindrical one, but this handicap can be overcome by using a separate socket; that means a specially made stump socket which will be inserted in the artificial leg as I have done in my first Pittsburgh case, Thomas Williams. (Here I used an above knee metal leg with inserted wood socket).

The merits of this new type of artificial leg are great and evident when one mentions the harrasing things that have been connected with the wearing of any ordinary leg such as necessity for stump socks, waist or shoulder suspenders, harnesses, hip joints, and pelvic belts, which are the cause for much discomfort, sweating and rubbing and sore places.

I am confident the suction socket can be used for artificial arms too, thus giving these amputees similar benefits. It should have great possibilities since in my estimation about 60% of all above knee amputation cases could be fitted with suction sockets, regardless of favorable length and condition of the stump. The socket can be attached to any make of limb, such as wood, fibre, plastic, etc. The suction socket can be worn as inner socket.